

# ***Lateralus – Tool***

## *Introduction:*

I chose the song “Lateralus” by the progressive rock band Tool released on May 15, 2001. This was the single from the album by the same name which debuted number 1 on the Billboard top 200, and Tool won a Grammy for Best metal performance for this album in 2002.

Theme – This song is about the desires of humans to explore and expand on knowledge<sup>1</sup>

This song is very interesting to me personally because it has a special connection with the Fibonacci sequence. - 1, 1, 2, 3, 5, 8, 13...

### Connection with Fibonacci -

1) The lyrics of the verse have syllables of lengths 1, 1, 2, 3, 5 and follow a rise and fall of numbers within this sequence.

Example : Black (1), then (1)

white are (2)

all I see (3)

In my in-fan-cy (5)

Red and yel-low then came to be (8)

2) The intro part of the song is 1 minute 37 seconds long and leads to a build up of percussions leading into the song. It gives a feeling of what is to come, a trance like song with many repetitions of thematic elements.

3) The chorus of the song has a time signature of 9/8 8/8 and 7/8. This 987 time signature is also shown as an element of the fibonacci sequence and has led to many fan theories for more connections with the fibonacci sequence (which may or may not have been intended by the composers).

I have analyzed this song in both midi, audio domain and visually making symbolic summarizations of the structure of this song.

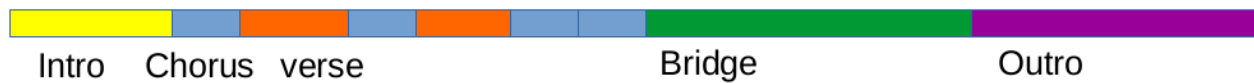
I made my final goal of this analysis to be able to identify repetitive structure and wrote a code (in Summarizing.html) to be able to summarize the representative parts of this highly repetitive song by a parameter. Using parameters for length of segment and number of clusters different summaries can be obtained.

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<sup>1</sup> [https://en.wikipedia.org/wiki/Lateralus\\_\(song\)](https://en.wikipedia.org/wiki/Lateralus_(song))

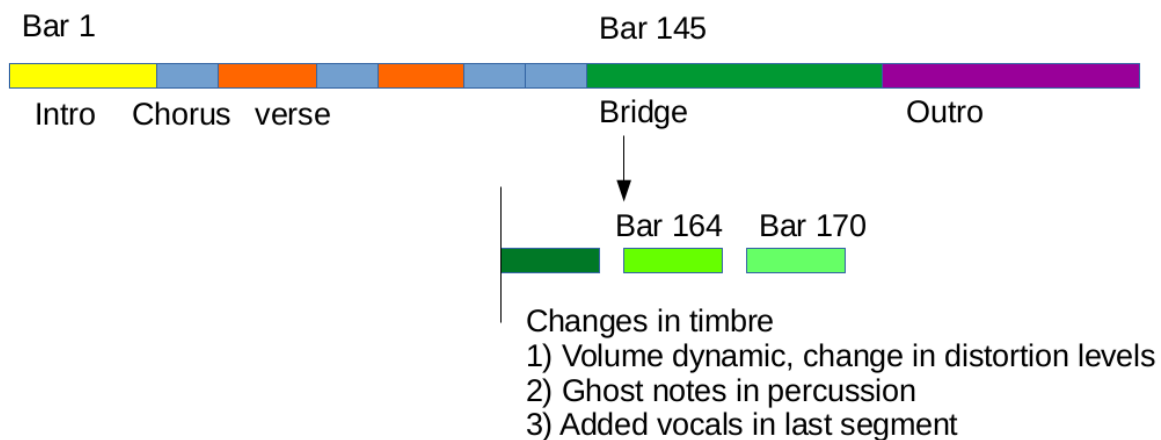
## Visual Analysis:

Bar 1

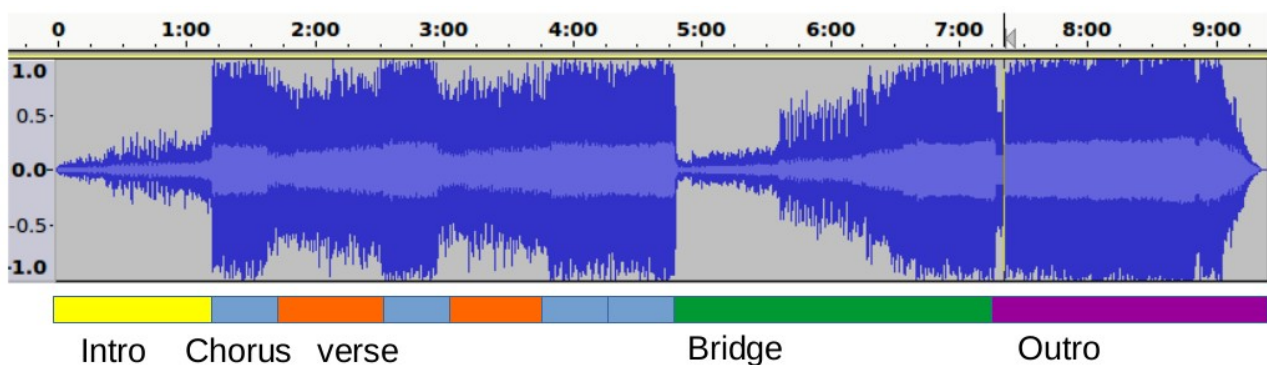


The song of length 9 minutes 24 seconds was observed and broken into these segments visually. This kind of division was later performed for both audio domain and midi domain for the analysis.

I made further symbolic categorizations in the time line to draw the following representative structure



Visually on looking at the wav file in (audacity) or (sonic visualizer) it was easy to observe the same categorization purely by observed energy.



This means that it must be easy to identify the same perceptual segments purely from low level audio descriptors like spectral centroid, energy and mfcc.

## Score Analysis:

By looking at the score for each of these segments we observe that this song is melodically pretty simple. But the complexity and interest of this song lies in the complex rhythmic structures that constantly change through out the song.

- Chorus - 9/8 8/8 7/8

Images of midi from MuseScore



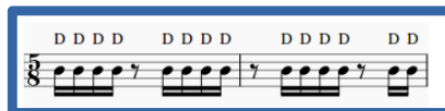
The image shows a musical score for the chorus of a song. It consists of three staves: El. Guit., B. Guit., and Drs. The time signature changes from 9/8 to 8/8 to 7/8. The El. Guit. staff has two blue boxes highlighting specific rhythmic patterns. The B. Guit. staff has a blue box highlighting a specific rhythmic pattern. The Drs. staff has a blue box highlighting a specific rhythmic pattern.

The chorus has a unique time signature of 9/8 8/8 and 7/8 while the other parts of the song go into other time signatures (intro of 6/8, 12/8, bridge verse 5/8).

I would also like to point out another interesting aspect observable from the score of the percussion. In a major section of the song which I have indicated as the bridge, the score is written in 5/8 but the hi hat follows a longer pattern that bleeds across two consecutive bars. This leads to multiple perceptual groups (by gestalt principles of grouping and continuity).

Demonstration :

The simple 5/8 notation of the score is given here (in the score for the bass melody)



The image shows a musical score for the bass melody in 5/8 time. It consists of a single staff. A blue box highlights a specific rhythmic pattern.

while the hi hat is grouped across two consecutive bars seen here in the blue squares.



The image shows a musical score for the bridge of a song. It consists of four staves: El. Guit., El. Guit., B. Guit., and Drs. The time signature is 5/8. The B. Guit. staff has a blue box highlighting a specific rhythmic pattern. The Drs. staff has a blue box highlighting a specific rhythmic pattern.

The motivation for summarizing the repetitive nature of the song is seen by looking for other symbolic representations of the song. I searched for other symbolic representations to find guitar tabs that were of the following nature

```

E|-----|
B|-----|
G|-----|
D|--0--0--0--0--| x4
A|--0--0--0--0--|
D|--0--0--0--0--|

(7:17)

E|-----|
B|-----|
G|-----|
D|--x--0--0--| x40  <-----
A|--x--0--0--|
D|--x--0--0--|

E|-----|
B|--15-15--13-13--15-15--18-18--15-15--13-13--18-18--15-15--|
G|--14-14--12-12--14-14--17-17--14-14--12-12--17-17--14-14--|
D|--12-12--10-10--12-12--15-15--12-12--10-10--15-15--12-12--|
A|--12-12--10-10--12-12--15-15--12-12--10-10--15-15--12-12--|
D|--12-12--10-10--12-12--15-15--12-12--10-10--15-15--12-12--|

E|-----|
B|-----|
G|-----|
D|--x-5--5--| x7
A|--x-5--5--|
D|--x-5--5--|

```

The x 40 shows the extent of repetition

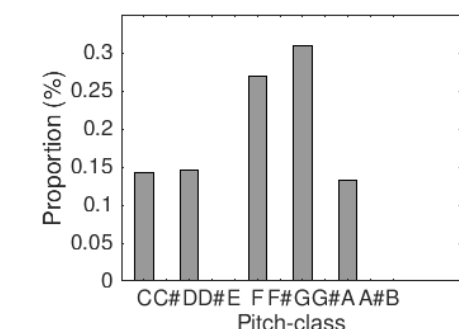
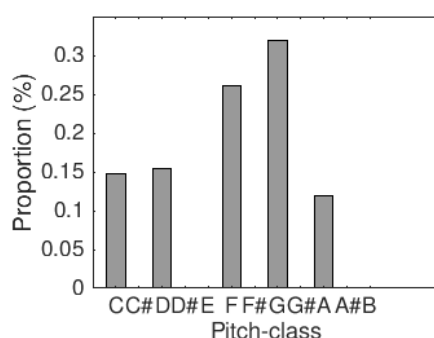
Most of the interest in the song is in the complicated rhythm groupings and the development in the timbre of the instrument in the audio domain, which I will get to in my summarizing codes built on the timbre.

## Midi Analysis:

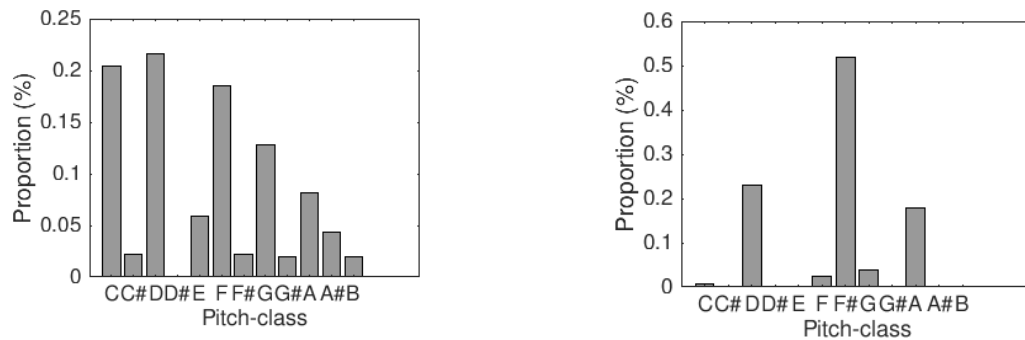
The midi of the song was obtained from a free resource online and includes 262 bars with 10 instruments. (electric guitar, bass guitar, percussions, fretless bass).

I used midi toolbox in matlab for running most of the analysis. I divided the entire song into 4 different segments which I wanted to analyze against each other. Intro\_mid, Chorus\_mid, Bridge\_mid and outro\_mid.

Giving a pitch profile from each segment shows that miditoolbox was unsure of the pitch profiles of the song. The intro and chorus look similar while there is a clear difference in the bridge and outro

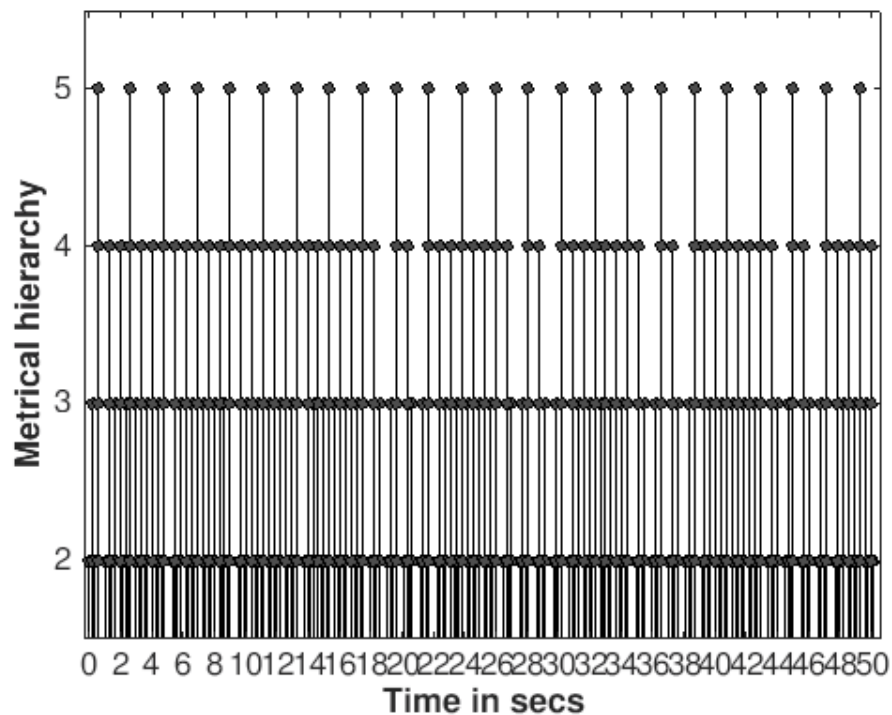


The bridge and outro pitch profile looks like the following :

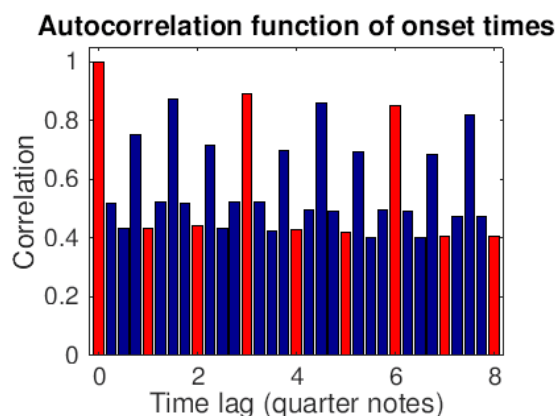


gettempo gave us a tempo of 85 for the intro and chorus and around 90 for the bridge and outro. This is close enough to the midi representation of the score. But since the meter keeps changing miditoolbox had a difficult time in analyzing the metrical heirarchy.

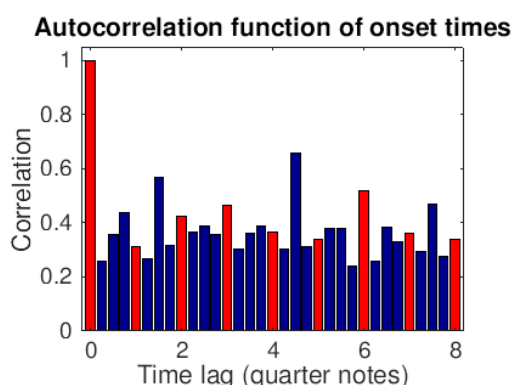
The metrical heirarchy obtained from just the intro shows that it identifies a 6/8 rhythm but it is inbuilt to show accents at 2, 4, 6 and 8.



A similar result can be seen in the onset autocorrelation of each of the segments. The intro looks like :



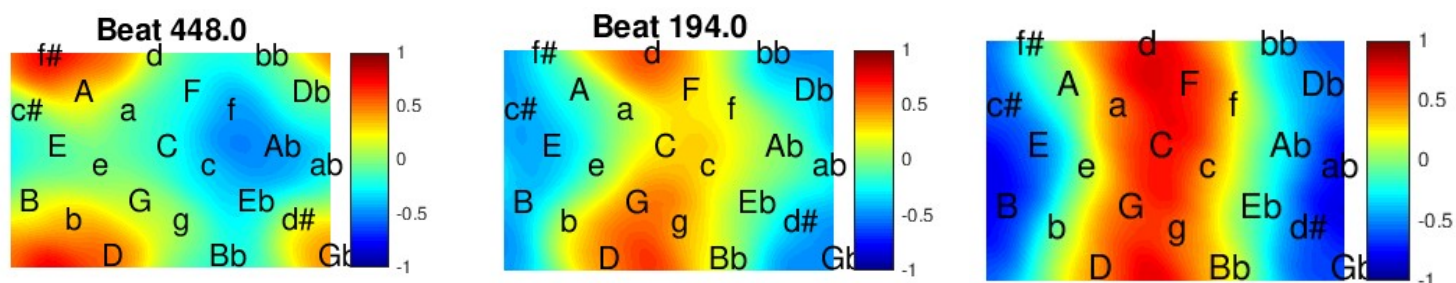
While the bridge looks like the following.



The difference in meter through the song is clear in the difference in correlations seen in the above to figures. The accents can be seen at other beats as well and the 6/8 and 5/8 meters can be inferred.

Tonal Analysis from Midi:

The tonality of this song is seen to be ambiguous at the introduction and other verse transients, while it has a very definite tonic of D and F at the chorus and bridge. You can also see the tonic shifting through the song in the following animation.

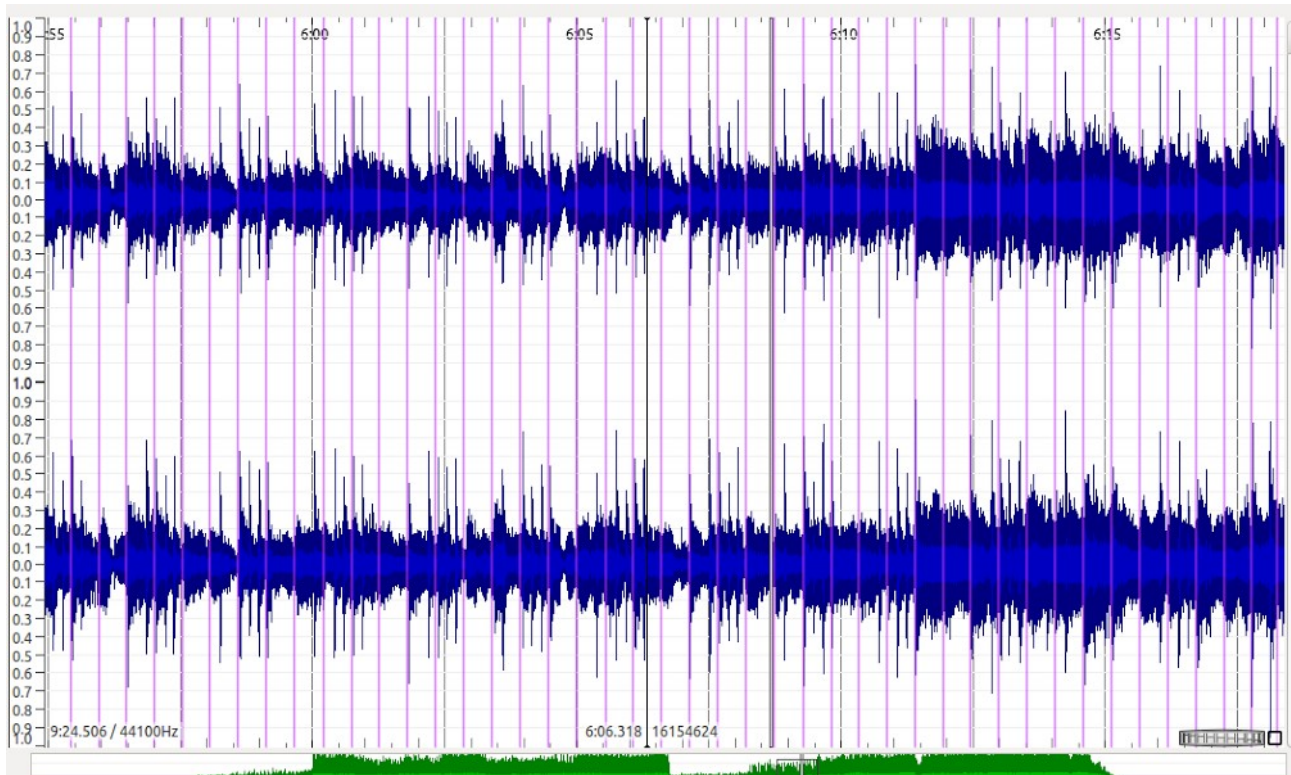


The animation of the development of the tonality is found in the keysom.ogg file in the zip folder.

## *Audio Analysis:*

The audio domain information was used for doing a rhythmic analysis and also for the main goal of making a parametrized summarization.

Using *essentia*, downbeats were identified to find the segments of the songs.



Sonic Visualizer was used to annotate these beats and auralize them for identifying the downbeats. The code can be seen in *BeatAnnotating* python notebook.

Low level features were also extracted and the *Summarizing* python notebook is a report of the summarization.

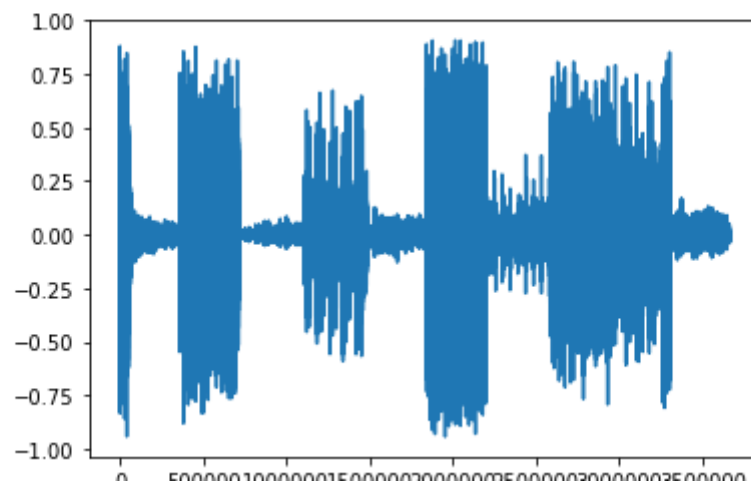
The song was divided into segments using 2 parameters – *SegmentLength* and number of *Clusters*

The final result of one of the summaries looked like the following



```
In [31]: x = loader()

from pylab import plot, show
plot(x)
show()
# Displays the summarized segments
```



This is a 1 minute 23 second long sequence of all the representative parts of the song.

The song was broken into segments of segment Length parameter and low level features were extracted from it. Mfcc mean was used to make the clusters and the most representative sounds from each segment cluster were chosen to be stitched together to create the new summary wav file.

The documentation of this can be seen in the Summarizing.ipynb file.

This was the generative part of the assignment, for manipulating the wav file's representation into a form of summary generated from the original wav file. The representative parts of the bridge, chorus and outro were found to be included in the summary.

## Meta Data:

Here is the acoustic brainz id for the acoustic fingerprint of the Lateralus song from 223 sources.  
<https://acoustid.org/fingerprint/26523554>

### Tags

alternative metal	3
hdcd	2
heavy metal	1
metal	1
pop/rock	1
progressive metal	1
progressive rock	1
rock	1

These are the tags associated with the song Lateralus from Music Brainz that could be used for understanding the language tags for similarity with other songs/genres